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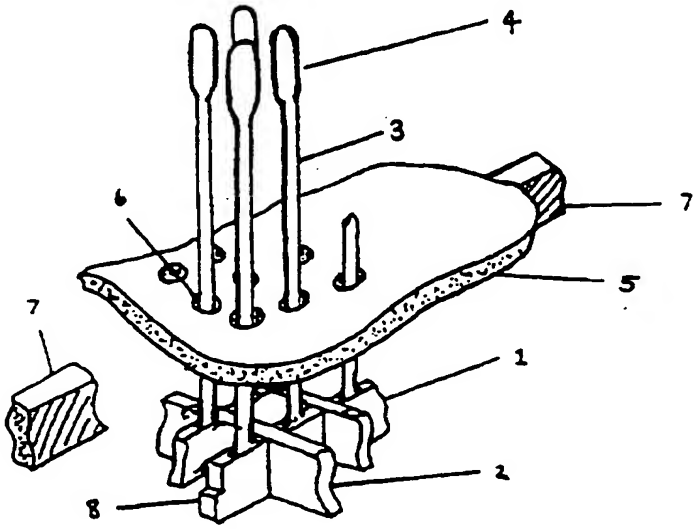
(54) Abstract Title
Artificial shock absorbing surface

(57) An artificial shock absorbing surface e.g. for use as a ski slope surface, includes an array of spaced apart upright resiliently flexible members supported by a base. The flexible members each have an upper head portion (4) and a lower stem portion (3) with the head portion (4) of each flexible member having greater transverse cross-sectional dimensions than that of the lower stem portion (3). The surface easily withstands downward directed force but on application of lateral force to the flexible members, the stem portions (3) flex so that the head portions (4) contact head portions (4) of adjacent flexible members. In a preferred embodiment, the base is formed from parallel base members (1) joined together by cross-wise connecting members (2). Preferably, strips of resilient damping material (7) are positioned between stem portions (3).



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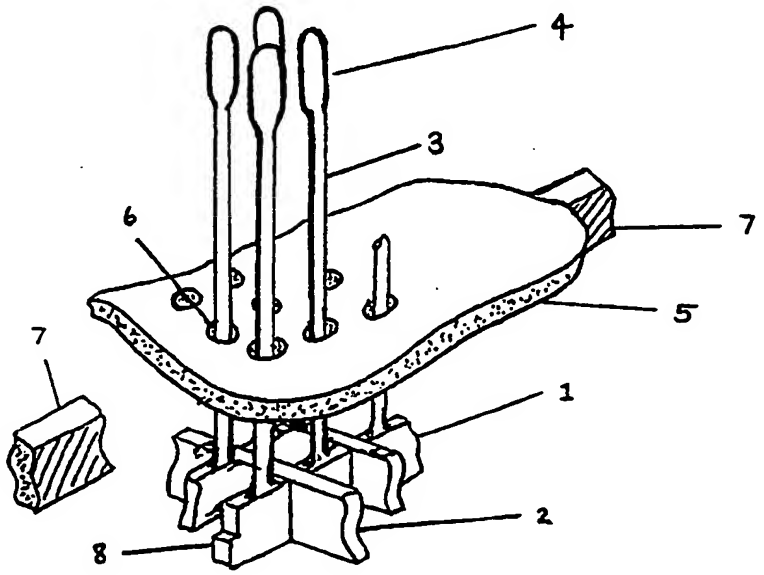

(57) Abstract

An artificial shock absorbing surface e.g. for use as a ski slope surface, includes an array of spaced apart upright resiliently flexible members supported by a base. The flexible members each have an upper head portion (4) and a lower stem portion (3) with the head portion (4) of each flexible member having greater transverse cross–sectional dimensions than that of the lower stem portion (3). The surface easily withstands downward directed force but on application of lateral force to the flexible members, the stem portions (3) flex so that the head portions (4) contact head portions (4) of adjacent flexible members. In a preferred embodiment, the base is formed from parallel base members (1) joined together by cross–wise connecting members (2). Preferably, strips of resilient damping material (7) are positioned between stem portions (3).

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ARTIFICIAL SHOCK ABSORBING SURFACE

Technical Field

The invention relates to an artificial shock absorbing surface, which may be used for example as a ground or wall surface, especially as a ground surface. In particular, the invention relates to artificial ski slope surfaces.

Background of the invention

Artificial materials have been used for many years in the construction of surfaces requiring the properties of low friction. Such low friction surfaces have a variety of uses and have been employed in the construction of artificial sports surfaces, in particular for winter sports, where geography or climate may prevent the practice of particular sports and recreations for most of the year. Artificial ski slopes have thus become widespread and allow both novices and enthusiasts to participate in snow sports throughout the year. However, skiing and snow -boarding are risk activities and injuries occur both on snow and on artificial surfaces. Hand and arm injuries are particularly common on artificial surfaces.

In order to ski satisfactorily on a particular surface, it is important that the surface not only offers low friction, allowing the skis to slide easily on the surface, but that it must also be able to provide

some resistance to the skis when they are turned and 'edged' into that surface, slowing the forward movement of the skier and allowing the skier to change direction.

Conventional artificial ski-surfaces are of three types: PVC bristle filaments held in stainless steel channels and fabricated in individual mats, injection-moulded rounded bristle and fabricated in units and carpet-like material fabricated in rolls of woven or injection moulded plastic (Sports Council Datasheet 20, 2nd Edition, March 1990). However each of these conventional surface types have disadvantages with respect to satisfactory simulation of the properties of snow, safety for the user and ease of maintenance. For example, simple carpet-type and injection-moulded surfaces demonstrate unacceptable levels of wear and dirt build-up and have low levels of consumer acceptance as a substitute for snow.

PVC bristle surfaces, e.g. "Dendix" (TM) ski mats, are generally considered to have greater consumer acceptance in terms of skiing performance. The bristle mats are generally constructed from strips of closely packed PVC bristle filaments held in stainless steel channels tied together at regular intervals to form a mesh like mat. The low friction required for skiing is partially achieved by the provision of large spaces in the mesh between the strips of bristle but typically needs to be enhanced with water sprinkler systems to keep

the bristles wet. However, such surfaces, although providing a surface of sufficiently low friction to allow skiers to slide over the surface, are still generally unsatisfactory in similarity to snow in terms of allowing the skier to create an 'edge' and turn on the surface. Furthermore, such mats do not provide the shock-absorbing properties of snow and so injuries on falling may occur due to, for example, arms and hands hitting the ground in the spaces between the strips of bristle and grazing of the skin occurring on contact with the bristles. Moreover the installation and maintenance of sprinkler and drainage systems is expensive. There is therefore a need for a surface which provides sufficient low friction together with shock-absorbing properties to reduce injury and which allows skiers to satisfactorily turn on the surface.

Summary of the Invention

It is an object of the invention to provide a shock absorbing surface which can reduce or avoid the disadvantages described above, particularly can avoid the need for water to reduce friction and can provide satisfactory properties as an artificial ski slope.

According to a first aspect of the invention, there is provided an artificial shock absorbing surface including:

an array of spaced apart upright resiliently flexible members,

said flexible members having an upper head portion and a lower stem portion, said head portion of each flexible member having greater transverse cross-sectional dimensions than that of the lower stem portion; and

a base which supports each of said flexible members at the stem portion;

wherein, on application of lateral force to the flexible members, the stem portions flex so that the head portions contact head portions of adjacent flexible members.

The artificial surface provided by the invention may be used as an artificial dry snow sports slope surface. For clarity of description, the flexible members are described as being upright. This is to be understood to mean upstanding from the base, when considering the base in a reference horizontal position. In, for example, the situation where the surface forms a wall surface, the flexible members may therefore be horizontally orientated.

The arrangement of an array of spaced apart upright resiliently flexible members each composed of a head portion supported by a narrower stem portion as described forms a surface which withstands downward directed force. However, on applying lateral or angular force to the surface, the stems of the flexible members bend, thus providing a cushioning effect. Lateral force is to be understood to mean any force directed at an angle other

than perpendicular to the plane of the surface. The coefficient of friction offered by the surface of the present invention is determined by the density, shape and material of construction of the head portions. Suitable low coefficient of friction of the overall surface can be obtained by use of inexpensive synthetic plastics material. The resistance to lateral and angular force is determined by the shape of the heads, the spacing of the flexible members, the relative and actual dimensions of the heads and stems, etc.

To provide the advantages of the present invention, the flexible members are spaced apart and are preferably substantially parallel. Preferably the distance between adjacent head portions in each of four perpendicular directions is no greater than three times the maximum width of each head portion (i.e. its width at its widest part). More preferably, the distance between adjacent head portions in each of four perpendicular directions is no greater than two times the maximum width of each head portion. Most preferably, the distance between adjacent head portions in each of four perpendicular directions is no greater than the maximum width of each head portion. In a preferred embodiment, the distance between the widest part of adjacent head portions is no greater than 1 cm in each of four perpendicular directions.

The head portions of the flexible members must have greater cross sectional area than the stem portions.

Preferably, the maximum width of each head portion is at least 50% greater than the minimum width of the stem portion. More preferably, the maximum width of each head portion is at least 100% greater than the minimum width of the stem portion. In this context, the maximum width refers to the width of the head portion at its widest part and the minimum width refers to the width of the stem portion at its narrowest part. In a preferred embodiment, the maximum width of the head portion is not less than 5 mm, more preferably not less than 1 cm.

When lateral force is applied to the surface of the present invention, such as when an object impacts on the surface, the stem portions flex, causing the head portions to contact adjacent head portions. As more head portions are pushed against each other the resistance to the applied force gradually increases, creating a banking effect in which the head portions form a sloping surface which slopes upwards from the site of impact, thus urging the impacting object towards the top surface of the head portions and allowing a gradual deceleration, causing less damage to the fallen object, or, in the case of e.g. a fallen skier, reduced likelihood of injury. The head portions may be of any shape but are preferably shaped to have no sharp edges which may cause injury or damage to a person or object impacting on the surface. Preferably at least the upper surface of the head portion is rounded in a dome-shape to reduce the coefficient of

friction and to reduce wear to the surface. The provision of such a dome-shape on the upper surface of each head portion also facilitates smooth penetration of for example a knee or elbow into the surface, dispersing the head portions in a shock absorbing manner. Further, the head portions are preferably elongated such that the head portions are greater in length than in maximum width. This facilitates greater contact with adjacent head portions when lateral force is applied to the surface. Optionally, the head portions may have ribs and may have bristles to adjust the frictional properties of the surface. In this way, the properties of different snow surfaces may be simulated. The head portions may be solid or hollow and may have at least one recess or at least one hole through the body of the head portion in order to reduce weight.

The shock absorption properties of the surface and the flexibility of the flexible members of the present invention, are at least partly determined by the height of the flexible members and the width of the stem portions. Preferably, the height of the flexible members are not less than 2 cm. More preferably, the height of each flexible member is not less than 5 cm. Most preferably, the height of the flexible members of the present invention are not less than 10 cm. Preferably, the diameter of each stem is not less than 2 mm at its widest part. Optionally, the stems may taper to provide

variable rigidity to the flexible members with greater flexibility at the upper ends of the stems than at the lower ends. This results in increased resistance to an object falling into the stems as the object falls downwards through the stems towards the base, and causes the stems to bend uniformly, helping to prevent damage.

Optionally, resilient damping material e.g. strips of synthetic foam material, may be positioned between the stems of the flexible members. The resilient damping material allows adjustment of the shock absorption properties of the surface and the flexibility of the stems, cushions any object or limb penetrating between the flexible members and prevents them from impacting on the base or the underlying surface, reduces vibration, and reduces noise. Optionally, damping material or other means of shock absorption can be provided underneath the base to enhance shock absorption properties. For example, springs, shock absorbing resilient members and the like may be attached to or integrally moulded with the lower surface of the base.

The flexible members and base of the present invention are preferably manufactured from injection moulded PBT (polybutylene terephthalate) but can be made of any suitable hard-wearing plastics material such as polypropylene, nylon or other polyester. The base preferably comprises a plurality of base members each of which is preferably moulded in one-piece with a plurality

of flexible members. Preferably the base members are formed in strips and are substantially coplanar with the stem portions of the flexible members. Optionally, flexible members may also be provided on the connecting members. The base member strips may be formed in any size but are preferably manufactured in strips greater than 20 cm in length. Optionally, the base may be formed by plastics sheeting. Optionally, the flexible members may be manufactured separately from the base and connected to the base e.g. by plastic welding of the stem portions to the base, screwing the stem portions into the base or press fitting the stems into sockets in the base. Furthermore, the head portions of the flexible members may be manufactured separately and e.g. screwed onto the stem portions. In this way, components of the surface can easily be replaced when damaged or when it is desired to change the friction or shock absorbing properties of the surface. In addition, different coloured head portions may be incorporated e.g. to incorporate figures, e.g. advertising material, or mark out courses. The resilient damping material may be manufactured from a foam-like material and placed in strips between the stems. Alternatively, the damping material may be constructed as a sheet with holes through which the heads and stems may project. Alternatively, the damping material may be formed *in situ* around the stems of the assembled surface.

Preferably the surface has an area of at least 20 cm by 20 cm, in which the flexible members are in a substantially uniform array. More preferably the surface has an area of at least 1 m by 1 m, in which the flexible members are in a substantially uniform array. By substantially uniform it is meant that the flexible members are arranged in a substantially square array with each flexible member generally surrounded by and spaced apart from eight neighbouring flexible members, of which there are four mutually perpendicular nearer flexible members and four mutually perpendicular farther neighbours.

The surface can be supplied in e.g. continuous areas, rolls or as individual sections, which can easily be replaced. When assembled in sizeable areas, the surface is sufficiently flexible to conform to the contours of the surface to which it is applied.

Brief Description of the Drawings

The invention will now be described by way of non-limitative examples by reference to the embodiments shown in the accompanying drawings, in which:

Figure 1 is a perspective view of a portion of a first embodiment of the artificial shock absorbing surface of the present invention;

Figure 2 is a perspective view illustrating the means by which base members carrying flexible members can be joined together with connecting members to form the

base of the surface illustrated in Figure 1;

Figure 3 is a partly sectioned side view of the flexure of the flexible members of the surface illustrated in Figure 1 when lateral forces are applied;

Figure 4 is a plan view of displacement of the head portions of the flexible members when lateral forces are applied;

Figure 5 is a plan view of interlocking base members and connecting members as illustrated in Figures 1 and 2;

Figure 6 is a partially sectioned perspective view of the base and stem portions of a second embodiment of the present invention;

Figure 7 is a side view, partially sectioned, of the base and stem portions of a third embodiment of the present invention.

Description of the Embodiments

Figure 1 shows a surface embodying the invention with an array of parallel spaced apart upright flexible members, each flexible member including a head portion 4 and a stem portion 3. The stem portions 3 are moulded as one-piece with base member strips 1, parallel base member strips 1 being joined together cross-wise by connecting members 2. Damping strips 7 made of low resilience material, e.g. plastics foam are positioned between rows of stem portions 3 with further damping material provided by foam damping sheet 5, which is positioned by pushing

the head portions 4 and stem portions 3 of the flexible members through the holes 6 in the damping sheet 5. The head portions 4 are wider in cross section than the stem portions 3, providing a greater density in the plane of the head portions 4 than in the plane of the supporting stem portions 3, and have a domed upper surface, providing a low friction, hard wearing surface. Furthermore, in the embodiment illustrated in Figure 1, the head portions 4 are elongated such that they are greater in length than in width, facilitating greater contact with adjacent head portions 4 when the flexible members are flexed, and have gently concaved joints with the stem portions to prevent e.g. finger entrapment.

Figure 2 illustrates the method of connection of the base member strips 1 with the connecting members 2 in the embodiment of Figure 1. Parallel base member strips 1 are joined to connecting members 2 by regularly spaced cooperating slots 9 in the base member strips 1 and the connecting members 2. The base member strips 1 can be connected in a staggered format as illustrated in Figure 5, thus eliminating in-line weak areas. End-on connections between individual base member strips 1 or connecting members 2, such as at joint 13 between base member strips 1a and 1b in Figure 5, are made by butt joints 8, as illustrated in Figure 1. Optionally, connecting members 2 may be affixed to the ground to hold the assembled grid system in position.

In the embodiment shown in Figure 1, the flexible members and supporting base member strips 1 and connecting members 2 are made of injection moulded PBT. Each flexible member is approximately 120 mm long with the head portion having a length of 30 mm and a diameter at its widest point of 10 mm. The stem portions have a length of 90 mm. The stem portions taper from a diameter of approximately 5mm at the lower end of the stem portion to approximately 4mm at the upper end. Each head portion is spaced apart from the four nearest adjacent head portions by approximately 6 mm. The cooperating slots of base member strips 1 and connecting members 2 are of dimensions 5 mm x 5 mm x 10 mm.

The flexible members constructed in such an array form a substantially uniform surface which easily withstands downward directed force, such as that which might be exerted by walking, skiing or snowboarding. However, as shown in Figures 3 and 4, on exerting lateral force as indicated by arrows 11 and 12, such as that which might be exerted by e.g. a ski or snowboard 10 being 'edged' against the direction of motion, the stem portions 3 of the flexible members bend, causing the head portions 4 to push against adjacent head portions 4, gradually increasing the resistance to the applied force. The elongated shape of the head portions 4 increases the surface area against which the lateral force may be applied and with which the head portions 4 can contact

adjacent head portions. Tapering of the stem portions 3 gives variable rigidity to the stem portions 3 and results in uniform bending along the length of each stem portion 3.

Figure 6 shows a second embodiment of the invention in which the stem portions 3 of the flexible members are screwed into sockets 14 of a semi-flexible plastics material base sheet 15, which is cushioned by an underlying sheet of foam 16. In an alternative embodiment as illustrated in Figure 7, resilient plastics material members 17 may be attached to the lower surfaces of the base member strips 1 or connecting members 2 of the embodiment shown in Figure 1 or the base sheet 15 of the embodiment shown in Figure 6. The resilient members 17 flex in the directions indicated by arrows 18 and 19 to increase the shock absorption properties of the surface.

The artificial shock absorbing surface of the present invention has been described with reference to a snow sports slope but it may be used for a variety of other purposes including, but not limited to, shock absorbing floor surfaces, floor surfaces which allow drainage of liquids, floor surfaces to be used to remove debris or dirt from the soles of shoes or boots, aircraft crash landing strips, shock absorbing crash walls and surfaces, vehicle crumple zones, boat launching strips both fixed and portable, marina fenders, shock absorbing

play area surfaces, slide surfaces for funfair rides or water park rides, surface to line bottom of swimming pools, wave breaking material for use in protection against coastal erosion, racks for holding fragile objects of variable shape, e.g. for use in dishwashers, and surfaces to discourage animals from traversing that surface, e.g. cattle grids. In addition, the surface may be utilised in fish farms to protect eggs from predators. Laid eggs would fall through the spaces between the flexible members with the dense head portions preventing the access of predators. Similarly, in horticulture seeds and seedlings could be planted in growing medium around the lower ends of the stem portions and would be protected from birds etc. during growth while still allowing access to growers through the flexible members.

While the invention has been illustrated herein by embodiments, it is not limited to those embodiments, and modifications and variations may be made within the scope and concept of the invention herein disclosed.

CLAIMS

1. An artificial shock absorbing surface including:

an array of spaced apart upright resiliently flexible members,

said flexible members having an upper head portion and a lower stem portion, said head portion of each flexible member having greater transverse cross-sectional dimensions than that of the lower stem portion; and

a base which supports each of said flexible members at the stem portion;

wherein, on application of lateral force to the flexible members, the stem portions flex so that the head portions contact head portions of adjacent flexible members.

2. An artificial surface according to claim 1, wherein the lower ends of said stem portions are spaced apart on the supporting base.

3. An artificial surface according to claim 1 or 2, wherein the stem portion tapers towards the head portion.

4. An artificial surface according to any of claims 1 to 3, wherein the head portion is elongated such that it is greater in length than in maximum width.

5. An artificial surface according to any one of the preceding claims, wherein the head portion has a maximum width of not less than 5 mm.

6. An artificial surface according to any one of the preceding claims, wherein the head portion has a maximum width of not less than 10 mm.

7. An artificial surface according to any one of the preceding claims, wherein the distance between adjacent head portions in each of four perpendicular directions is not greater than three times the maximum width of each head portion.

8. An artificial surface according to any one of the preceding claims, wherein the distance between adjacent head portions in each of four perpendicular directions is not greater than two times the maximum width of each head portion.

9. An artificial surface according to any one of the preceding claims, wherein the distance between adjacent head portions in each of four perpendicular directions is not greater than the maximum width of each head portion.

10. An artificial surface according to any one of the preceding claims, wherein the spaces between adjacent

head portions are not greater than 1 cm in each of four perpendicular directions.

11. An artificial surface according to any one of the preceding claims, wherein the maximum width of each said head portion is at least 50% greater than the minimum width of each said stem portion.

12. An artificial surface according to any one of the preceding claims, wherein the maximum width of each said head portion is at least 100% greater than the minimum width of each said stem portion.

13. An artificial surface according to any one of the preceding claims, wherein the stems of the flexible members are positioned not less than 5 mm apart.

14. An artificial surface according to any one of the preceding claims, wherein the stems of the flexible members are not less than 2 mm in diameter.

15. An artificial surface according to any one of the preceding claims, wherein the flexible members are not less than 2 cm in height, preferably not less than 5 cm in height, more preferably not less than 10 cm in height.

16. An artificial surface according to any one of the

preceding claims, wherein each flexible member is one piece of synthetic plastics material.

17. An artificial surface according to any one of the preceding claims, wherein said base comprises a plurality of base members, each of which is in one piece with a plurality of said flexible members.

18. An artificial surface according to claim 17, wherein each said base member has a strip shape and is substantially coplanar with the stem portions of its flexible members.

19. An artificial surface according to any one of the preceding claims, wherein said base comprises parallel strips carrying said flexible members joined together by cross-wise connecting members.

20. An artificial surface according to any one of the preceding claims, wherein resilient shock absorbing members are provided on the underside of the base.

21. An artificial surface according to any one of the preceding claims, wherein the head portions of the flexible members have a domed top surface.

22. An artificial surface according to any one of the

preceding claims, wherein resilient damping material is positioned between the stems of the flexible members to damp their vibration.

23. An artificial surface according to any one of the preceding claims, having an area of at least 20 cm by 20 cm, in which said flexible members are in a substantially uniform array.

24. An artificial surface according to claim 22, having an area of at least 1 m by 1 m, in which said flexible members are in a substantially uniform array.

25. An artificial snow sport slope having an artificial surface as defined in any one of the preceding claims.

FIG. 1

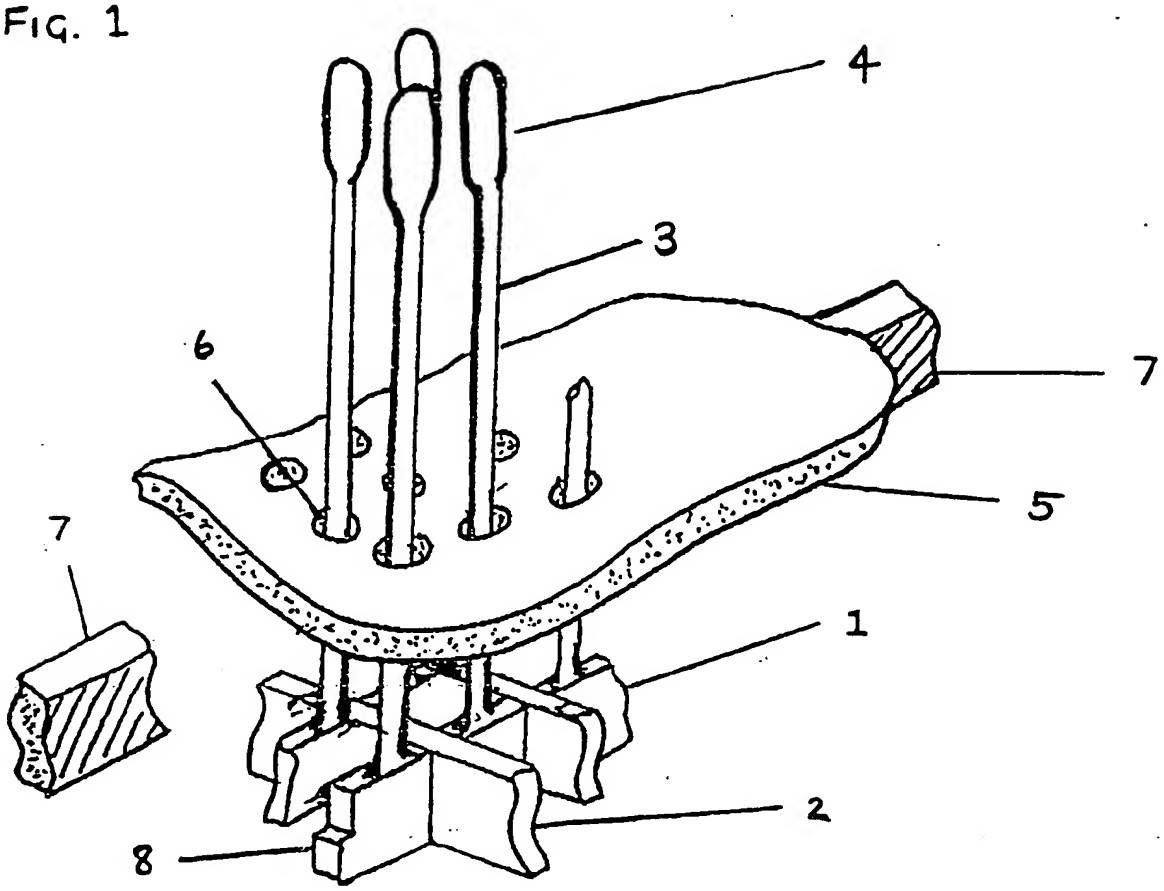


FIG 2

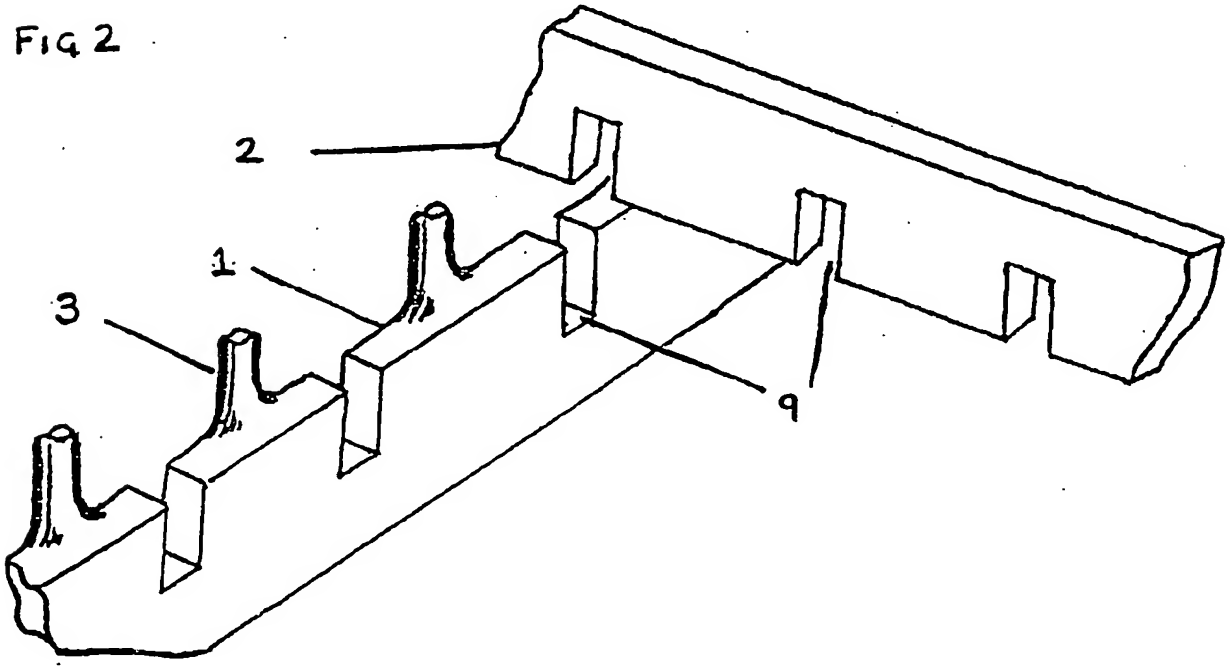


Fig. 3

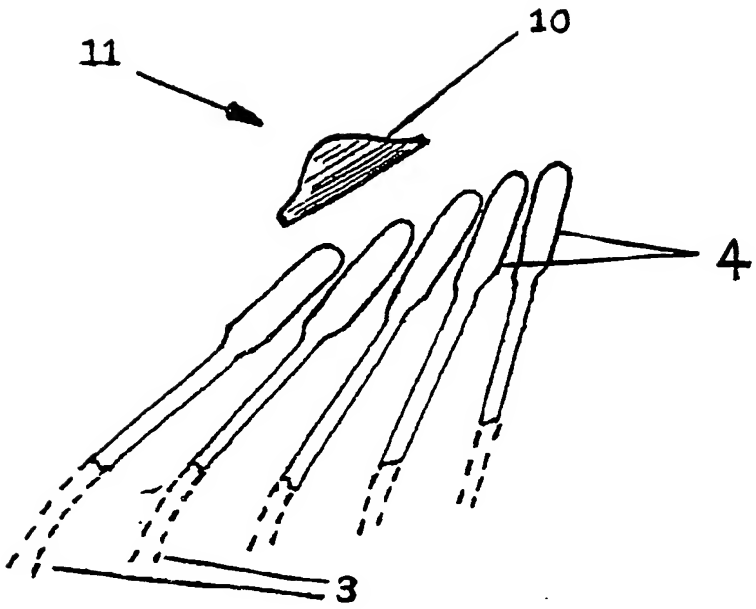


Fig. 4

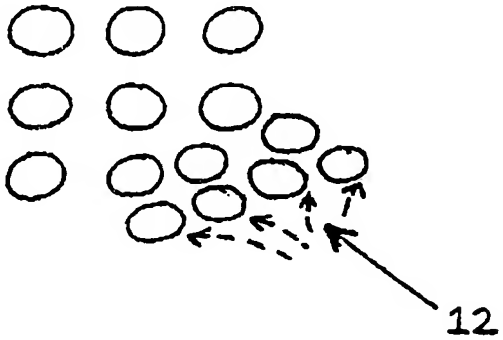


Fig. 5

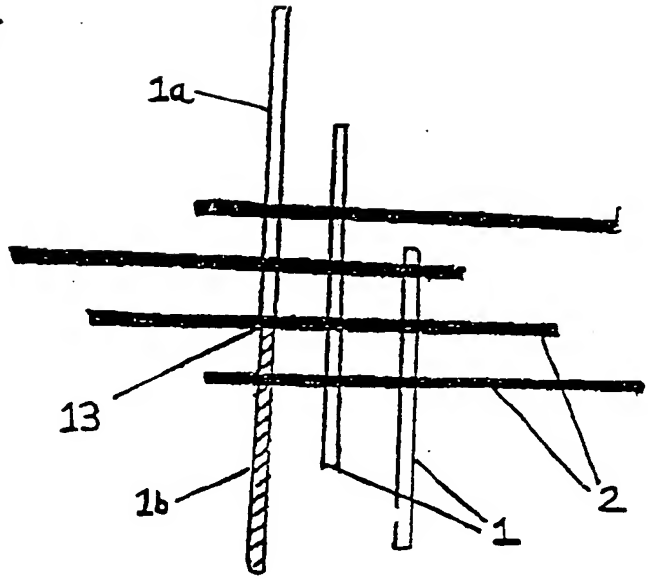


Fig. 6

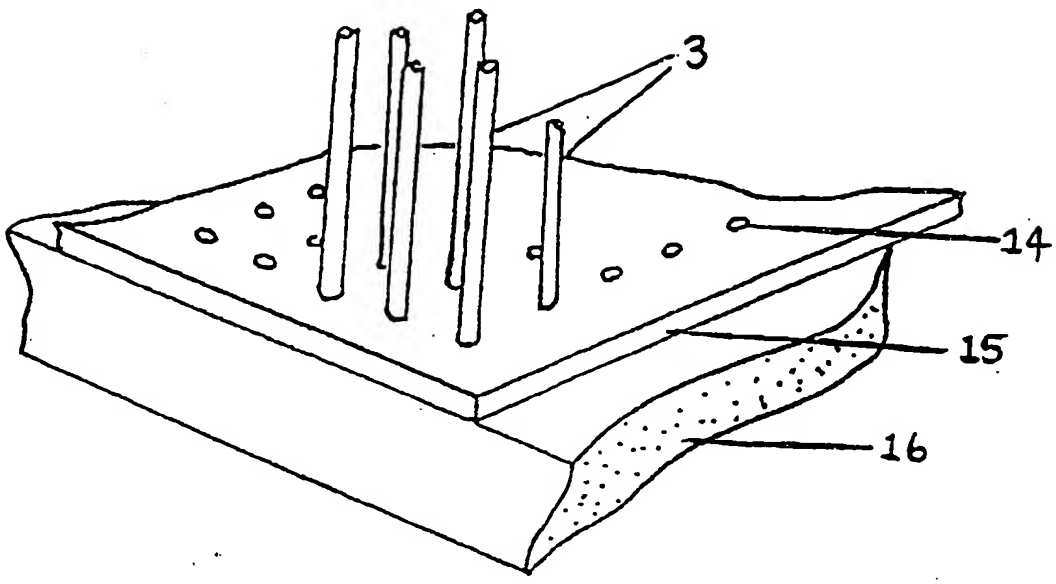
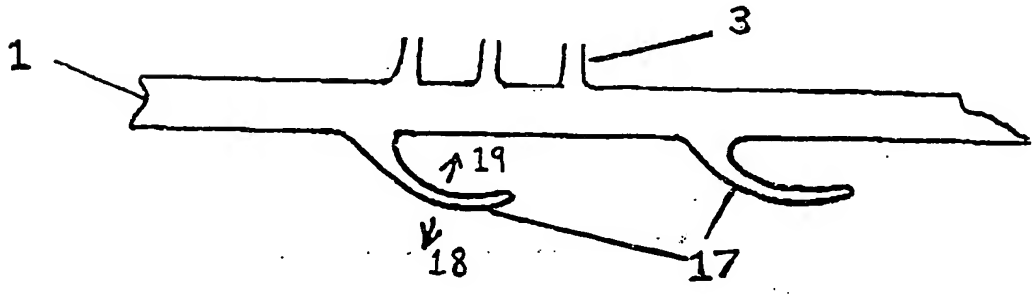


Fig. 7



INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER

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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: E01C, A63C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3574107 A (J.L. HURKA), 6 April 1971 (06.04.71), column 2, line 29 - line 34; column 2, line 49 - line 54, figure 2, details 10,4 --	1-2,21
X	US 3570846 A (A.P. WEBER ET AL), 16 March 1971 (16.03.71), figure 1, details 15,10 --	1-2,21
X	US 4179539 A (H. SCHWEIZER), 18 December 1979 (18.12.79), figure 4, detail 13 --	1-2,21
A	US 4087088 A (K.J. KELSO), 2 May 1978 (02.05.78), detail 10 --	20,22-25

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents
"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
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Date of the actual completion of the international search	Date of mailing of the international search report
25 June 1998	- 1. 07. 98
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+ 31-70) 340-3016	Authorized officer Örjan Nylund

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB 98/00762

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 3959542 A (P.A. LIVERMORE), 25 May 1976 (25.05.76), detail 14	19
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A	GB 2148131 A (R.S. HOPKINS), 30 May 1985 (30.05.85), figure 7	1
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S. :87953

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09/06/98

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PCT/GB 98/00762

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